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Ahn et al.

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(54) **METHOD OF AND APPARATUS FOR MONITORING CODE TO DETECT INTRUSION CODE**

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(51) **Int. Cl.**
G06F 21/00 (2006.01)

(52) **U.S. Cl.** **726/23**

(58) **Field of Classification Search** **726/22-25**
See application file for complete search history.

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Primary Examiner — Gilberto Barron, Jr.

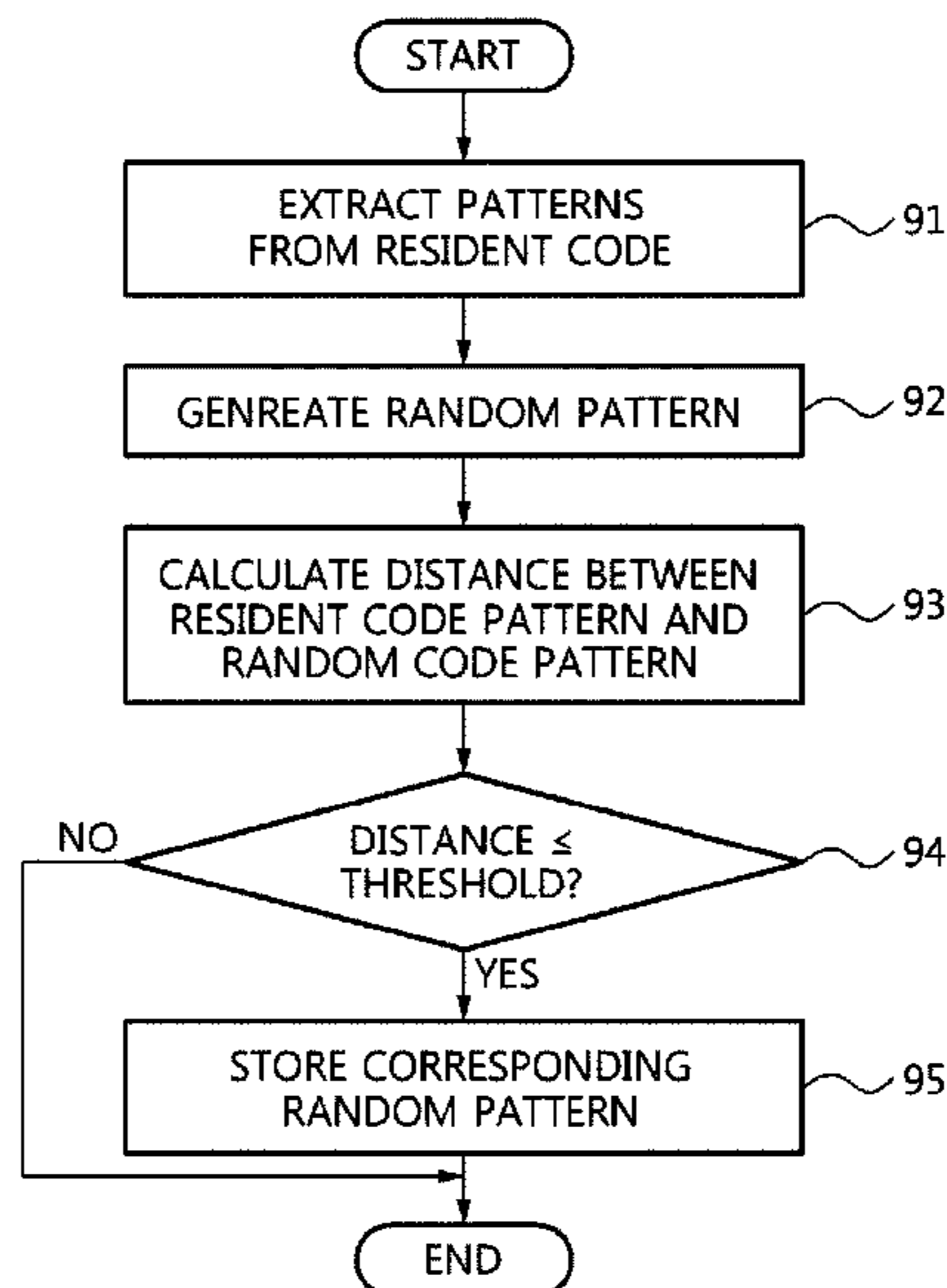
Assistant Examiner — David Le

(74) *Attorney, Agent, or Firm* — NSIP Law

(57) **ABSTRACT**

A method and apparatus for monitoring a code to detect intrusion code is used to monitor target code to determine whether the target code is a resident code in a system or an intrusion code into the system. A first code pattern is extracted from the target code and a second code pattern is loaded from a storage unit, and a distance between the first code pattern and the second code pattern is calculated. The calculated distance is compared to a threshold to determine whether the target code is an intrusion code.

28 Claims, 9 Drawing Sheets



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FIG. 1

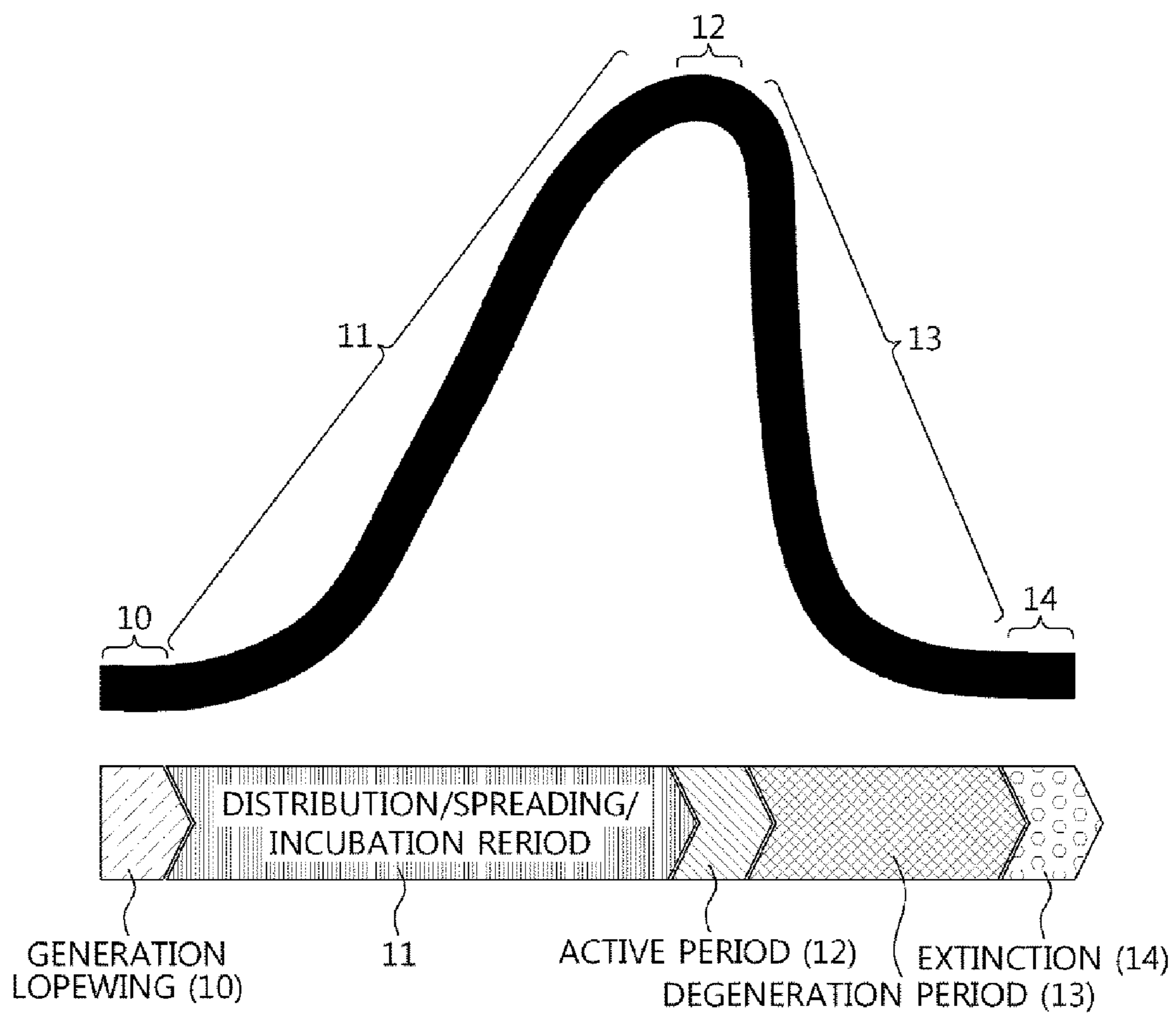


FIG. 2A

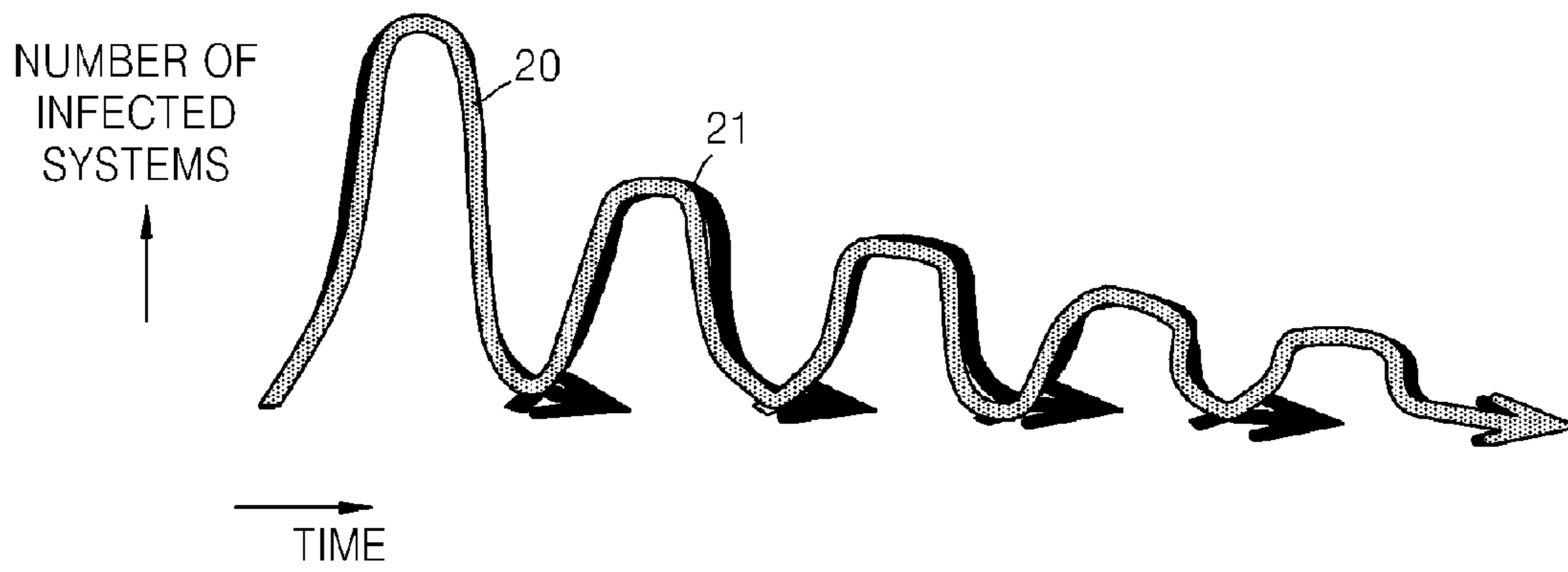


FIG. 2B

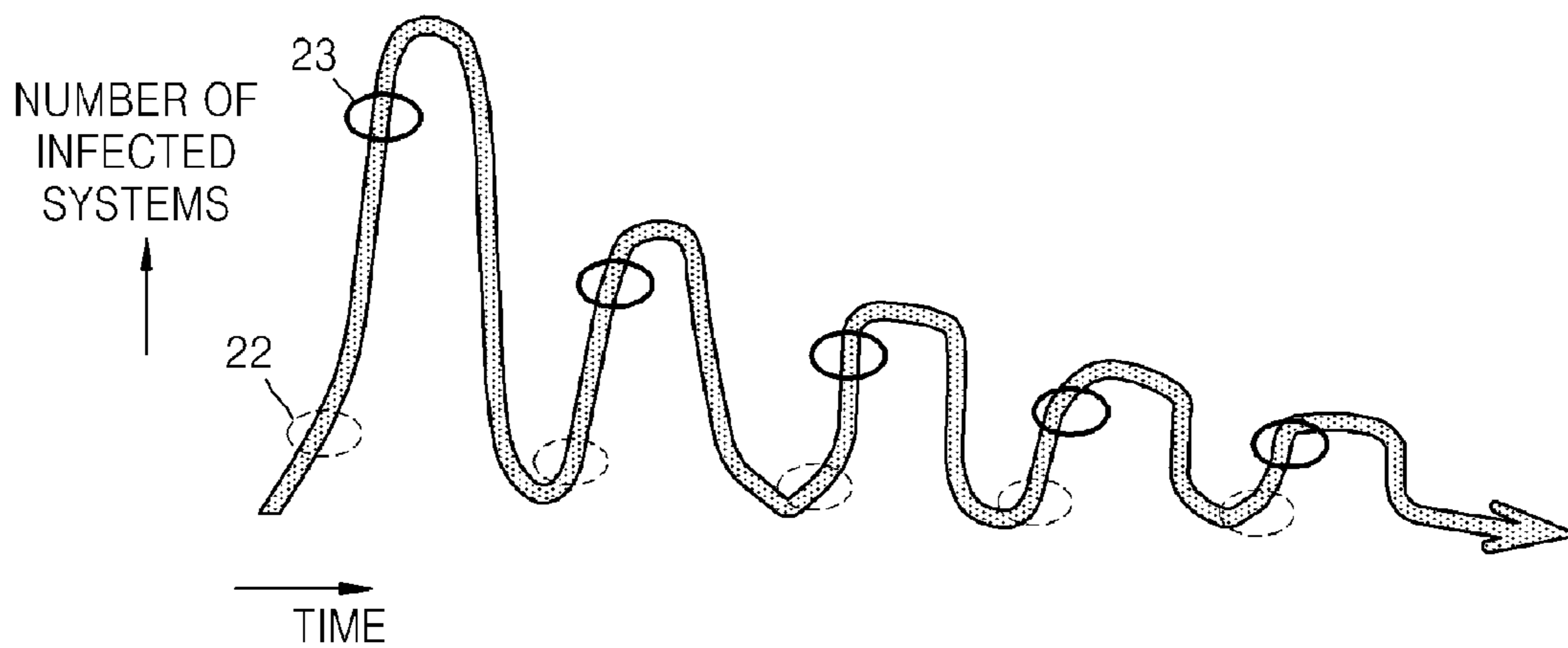


FIG. 3

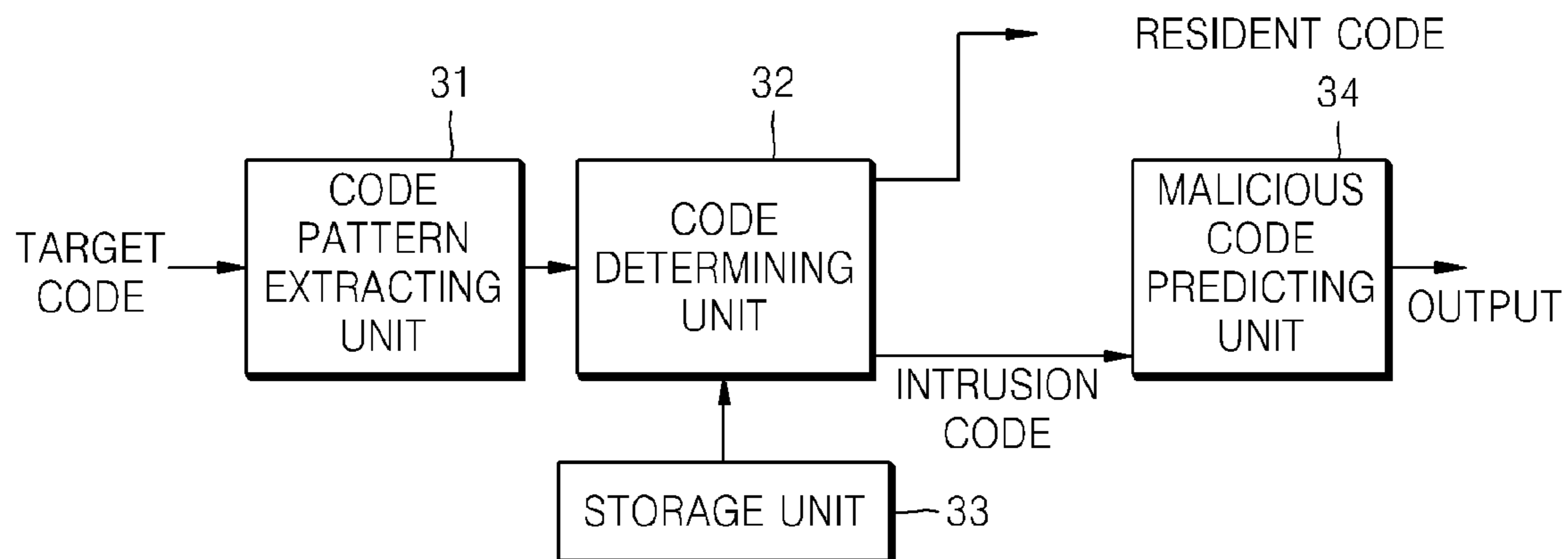


FIG. 4

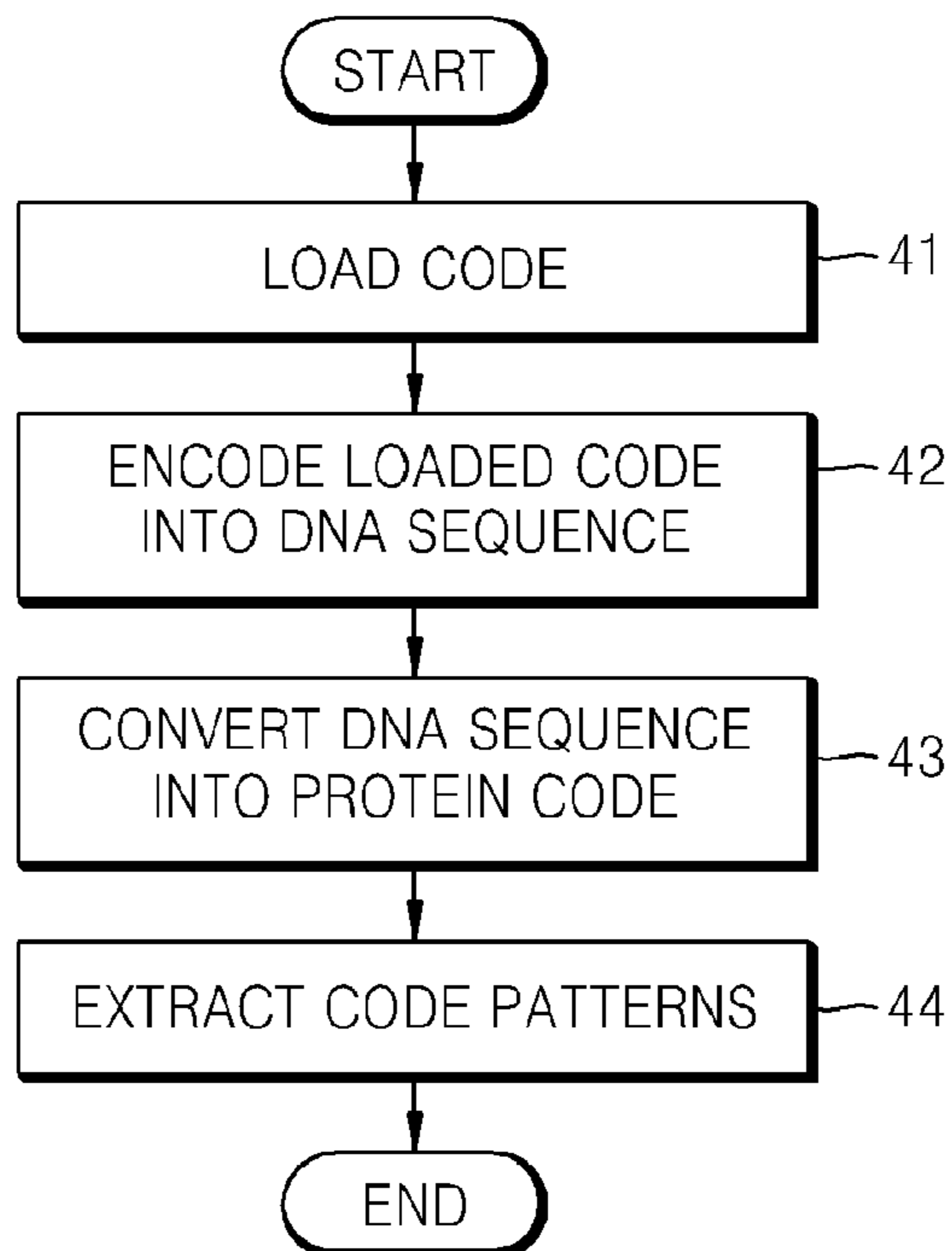


FIG. 5

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000000 4D 5A 90 00 03 00 00 00 04 00 00 00 FF FF 00 00
000010 B8 00 00 00 00 00 00 00 40 00 00 00 00 00 00 00
000020 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
000030 00 00 00 00 00 00 00 00 00 00 00 00 F0 00 00 00
000040 0E 1F BA 0E 00 B4 09 CD 21 B8 01 4C CD 21 54 68
000050 69 73 20 70 72 6F 67 72 61 6D 20 63 61 6E 6E 6F
000060 74 20 62 65 20 72 75 6E 20 69 6E 20 44 4F 53 20
000070 6D 6F 64 65 2E 0D 0D 0A 24 00 00 00 00 00 00 00
000080 B2 09 A7 41 F6 68 C9 12 F6 68 C9 12 F6 68 C9 12
000090 8D 74 C5 12 F4 68 C9 12 75 74 C7 12 F4 68 C9 12
0000a0 1E 77 C3 12 FD 68 C9 12 1E 77 CD 12 F2 68 C9 12
0000b0 F6 68 C8 12 0F 69 C9 12 94 77 DA 12 E7 68 C9 12
0000c0 1E 77 C2 12 C0 68 C9 12 4E 6E CF 12 F7 68 C9 12
0000d0 52 69 63 68 F6 68 C9 12 00 00 00 00 00 00 00 00
0000e0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0000f0 50 45 00 00 4C 01 05 00 1C 63 97 40 00 00 00 00
000100 00 00 00 00 00 E0 00 0F 01 0B 01 06 00 00 30 02 00
000110 00 20 01 00 00 00 00 00 DC 08 02 00 00 10 00 00
000120 00 40 02 00 00 00 40 00 00 10 00 00 00 10 00 00
000130 04 00 00 00 00 00 00 00 04 00 00 00 00 00 00 00
000140 00 60 03 00 00 10 00 00 00 00 00 00 02 00 00 00
000150 00 00 10 00 00 10 00 00 00 00 10 00 00 10 00 00
000160 00 00 00 00 10 00 00 00 00 00 00 00 00 00 00 00
000170 68 AF 02 00 DC 00 00 00 00 E0 02 00 10 72 00 00
000180 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
000190 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0001a0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0001b0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0001c0 00 00 00 00 00 00 00 00 00 40 02 00 04 07 00 00
0001d0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0001e0 00 00 00 00 00 00 00 00 2E 74 65 78 74 00 00 00
0001f0 C2 2D 02 00 00 10 00 00 00 30 02 00 00 10 00 00
000200 00 00 00 00 00 00 00 00 00 00 00 00 20 00 00 60
000210 2E 72 64 61 74 61 00 00 00 80 00 00 00 40 02 00
000220 00 80 00 00 00 40 02 00 00 00 00 00 00 00 00 00
000230 00 00 00 00 40 00 00 40 2E 64 61 74 61 00 00 00
000240 90 0A 00 00 00 C0 02 00 00 10 00 00 00 C0 02 00
000250 00 00 00 00 00 00 00 00 00 00 00 00 40 00 00 C0
000260 53 68 61 72 65 64 5F 45 10 02 00 00 00 D0 02 00
000270 00 10 00 00 00 D0 02 00 00 00 00 00 00 00 00 00
000280 00 00 00 00 40 00 00 C0 2E 72 73 72 63 00 00 00
000290 10 72 00 00 00 E0 02 00 00 80 00 00 00 E0 02 00
0002a0 00 00 00 00 00 00 00 00 00 00 00 00 40 00 00 40

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FIG. 6

GGTAATACCCCCAGCAAAAAGCCCGGGGATCTTCATAAGCACATCATAATTAGGTGGCAGAAA
CGACCCGCTGGACTAGTCGAACAGTAGGCGGGCCCGATCAAGAGTTGAAGACTTCGGGAATGGGC
GAAATACCACATAATCGCCGATGTTGGCTTGATGACTCTGTAGTCAGGTGAGAGTCAGGTGAGA
GTCAGGTGAGATCAATCTTAGAATCAGGTGAGATTCATCCTAGAATCAGGTGAGAGCCTCCAAGA
TCCAGGTGAGAGCCTCTCAGAGACAGGTGAGAGTCAGGAGAGACTGGTGAGAATTCTCGGTGACT
GAGGTGAGAGCCTCGAAGAAAAGGTGAGAGCAGCGCCAGACTCAGGTGAGAGATTGGCAGAGGG
TCAGGTGAGAAATTTAACATACCAGCTTAAAAAGCCGAAAAC TAAAAAAAAAAAAAAAAAGAAA
AAAAAAAAAAGGCCGACTAAGAAAGACAAAACGCATCTTGAGCATCGAATCAAAAAAAAAAGCGA
CATGTAGATCTAGAAAAAAAAAAAAAAAAAGCATGTAGATCTAGAATGAAAAAAAAAAAAAAAACA
TAGGTAGGACTTGATGCCTTTAAAAATAAAATAAAAAGCGACCACGACCAGAAAGACAAGAAAA
GAAAAGTTCCGATACAGGATGAACCTAGAACCTAGAACGAGTAGCTCAAAATAATAATAATA
ATAATAATAATAATAATAATAATGTTCCGATACAGGAGGTCAATAATCTGTTAGGTCCAAC
CAAATAACGAGTAGCTGAAAATAATCTAAACTAGAATGGTCCAAACAATAATAATAATTAG
TTAGAACAAAATAATAATAATAATAATAATAATAATAGCACTAGAACAAAATAATAATA
ATAATAATAATAATAATGTTCCGATCATAGTTAGGTGAAACTTAAATTCAGCTGAAACGAGCAA
CCGAGTAAGGGGGGGAAATCATTCCCCCCCCCAGGCCCGGGTGAGCAACTGAGTAAACCCT
TATTGTAGAAAATGGGCAGGGAACCTGAGTAAGAGCGCTGAAAATAATAATAATCAAACGATTTA
TTCAAACAATAAGGAACTCAACAATAGGATCCCGCAAATAATTCAAAATAATAATAATAATGA
AAAAT
AATAATAATAATAATAATAATAATCGATAAAAGGGAATCCCTTAATGTAGAACAAAATAATAATC
GATAAAAGGGAATCCCTTAATGTAGAACAAAATAATAATGGGCCAGGCACGGAAATGTAGAATA
TGTGATTTATCGAATAATATGTTCTTCGATACAATAGGGCTTGAATCATAAAGGCAGCCGTCAGC
CAAGCTAATAATATCGACCAAGGTCACCGCTACAGGTGAGAATCAGCCAAGGTAATAATATCGAC
CAAGGTTCCGCTACAGTGAGAACTAGAATAGAGAATAGAGCTAGAATTAATTCAAAGGACCGT
TGAACCCTTACAGTAGAACAGAGCTAGAACGAACAATACTAGTAAAGCGAGTACCTGCTATGTGA
TCAAAATAAGAAAAATAATAATAATAATGTTCCGATACAGGAGGTCAATAATCTGTTAGGTCTG
CGCAAATAACGAGTAGCTGAAAATAATGGGCCAGGCACGAAATGTAGAATATGTGATTTATGT
TCGATACTGAATCATATCAGCAAAGCTAATAATAAAGGGTCCGTCAGCAAAGGTAATAATAAGG
CCCGCAGCACTAATAATAACCCCCCCCCCAGGGCCCGCGCAACAATAGCTATGTGATCAAT
AAACAAAATAATAATAATCGAATAATAGTTTTAAACGATACATCAGGAGTAATGAATAGGTGGC
GAGCAAGGGAGCTGAAAATAATAATAATAATAATAATAATAATAATAATAATAATAATAATAATCGAATA

FIG. 7

NTPQKRRRSSZAHHNZUAQNDPLDZSNSRRRRSRUEDFANGRNTTZSPMLAZZLCKSGESQURURZDQSZ
 NQURFILESGESLQDPGESLSETGESQERLURILGDZGESLEEKGESSARLRZEIGRGSGEKFNIPAZKAE
 KLKKKKKKKKKKGRLLRQNASZASNQKKKATCRSRKKKKKKKHUDLEZKKKKTZUGLDAFKNKIKKRPRPED
 KKKKURYRMNLETRTSSSKZZZZZZZZZZZZZZCSIQEVIIGZUQPNEZLKNNLKLEWSNNNNNNZLEQN
 NNNNNNNNNSTRTKZZZZZZZZZZGSNHSZVKLKIQLKRATEZRGGNHSPPPQARUSNZUNPYCRKWAGNZU
 RALKNNNNQTIYSTIRNSTIGSRKZFKIIIIIMKNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNRZKGIPZC
 RTKZZSIKGNPLHNKIIMGPGTEMZNMZFIIEZYULRYNRAZIIKAAUSQANNIDQGHRYRZESAKUIIST
 KUPLQZELEZRIELELKFKGPLNPSRTELERTLUKRUPAMZSNKEKZZZZCSIQEVIIGZUCANNEZL
 KNNGPRHEMZNMFMDTESYQSSZZRURQQRZZZRPASTNNPPPPGPREQZLCDQINKIIIEZZFZN
 DTSRUMNRWRARELKNNNNNNNNNNNNNNNRIIURYNRPAAGGRARSZKIIIEZYMFDLIIQQGLRELYLR
 IUEQKGGGYPLKZNELNDHSRRSPFTYLEZKIPFLLUKNNNNNNNNNNNNRIIURYLRSKZKIEZCEZKGGK
 SPSSKRGEDIPFELKIPYSRTCZKIIIIIEZZFDTGIGRAKYPLKZNELKIPYSRSZKIMFDTGRRSL
 UKAQNNNNNNNNNNURYGRRSQAKFTSKGNPLPZMZRLKIIIMFDTFEPYQZRIGTZULUSKGGZALRPS
 PAEKZZQRTKZZZZZZZZZZCSIQGFALSUENRKSNNRARDRALKIIIIIIIIIMFDTKPSSRPPPPEQG
 UANNTSKNYPLPZKLKNNNNNNGPRNEMZNMZFIIEZYULKRYLRINNRGZREZYLIIKIRRZWRITIGESI
 IEZUPMIGZSNKREFNNTGRREZZGNRARSSPSTIASNANNPPPPGTRKSSNNNUIKZRNKALZSTIRC
 TRIIPNNMZNSTISGEZTGESTIYRGRZZAISNKREFNKETRTIGYRARAPPQQYZZCZZPPPPRWRQ
 KLEQZCDQIKKQSIGQSYLPKRSIKASDKAFDELCEQIGDPPPKSSNNNUIKZRNKAFRGGRARITPPQKL
 EQZCDQIKKRIIPSKZDIPPPKARTIMZSNKETNNTIEQGLPPPEQYKSYUIKZRNDKKSLEUEQNNNNNU
 RYRAGUIIGZUWANNEZLKNNURRYRTGUIIGZUGQITSSZKIMGPGLEMZNMZFIIEZYHFULRYNRLZI
 IEURUSDAPRSZTIQARUSYGNNTDEGWGGPRTISNNNZKREZAKRIGRTZNDDEPGGSQEYZANZAIZA
 TZAKZAIZARZATLUSRUPASRMZSNKEKZZZZZZZZZZCSIQEVIIGZULANNEZLKNNGPRQRNUEYUY
 URYZIIISATLIKVLUSNGNKGHGEHZZPPPPRZWRITAMZSNKQNNNNNNNGPRKRNUYUIQTSSIL
 NNKGMUNNTNNIGPGQZYEQIGPZZYRCWRRRTWSTIYRARARZWRRIWQATFHELVEKAZKSTNNTKKL
 MNQAIGSKNRPNYTZRESLKLIIWASKUWRRRUUNNSNIGZGQYZZYPPPPFRRTIAMZSNQNNNNN
 NNNNNNNNNHURIILRCSPKHPURIRRRRGURARSPMYRPUWRSPRHRAURURRQGPPPPGMLGIGH
 ZRIGQLGAGHLTIGZLGAGDRPPPPGYURERQLILRZSZAKACSZKIIIIIIIIAGENKIIIIIIIIICRG
 PGIENMZFKRICSSIQESASKNZSGENRPSQITSKEKDAAIKUERSRRGRPKGZYPFRPRARALLKIRKND
 LREZUEIPLIGTCEZAZNSGEATSKGTAKKAPGEETSKUPAKKGAASKATSMLKIRGRARARULRRRQLGR
 LRARZLRRACQQZRPCQQYLIIZGCQQZUIZAUNNSNIGTCQZZRANRPUIIQGGAKKUGUNNIIGPE
 QGLCEEGECQLZRADRARARRRYUSIIRANRLRUURRACURUKLKINEQZRZSLKILGGPEQGPCEEGGC
 EYZKSTNYIEKAZKSWEGPSKGCACKAURURLKINEZZRRSLZILGGHEQGGAKKURUTLKINEQYDKA
 ZKSWEUTSKGLAKKAVASKDTPPSTIUIIZDIUNMKZZYRULSTICNNIGGCQQZLIIISPPPQAFANNTLL
 ALCDQITKIIIIIIIIIMFDTGGZGCCZKSRNEDPIPGKTIIZNEISWUZSLNVEAQNNNNNNNNNNNNNN
 ZTKURIIIFDAEQGCCQIPANNNSIIGELSLSRTSZRSKZNKZGGGRSPZZGYUKNHTSKGGRGKSPZZU
 HUNNISKKUYACLNKRNELZSNNTUDNRPRAMPAZIKEKZZZZZZZZZZWAQEAQCRIKDLGSSMLNNKAD
 UNNTTKZATNNTGGCEEGUCEQYIPZZNKZRPRNRKRLMRNNKCPPLGGZDPLKZNQQYZZYPPPPRAQRT
 IPAMZSNKQNNNNNNNWRAPPIIIIIIIIIMFDTGGDASNPSKZALKIIIIIIIMGPGKKCRICDSNDL
 FDTFQQZGLSQZLIIQATUNNTSKZARNNIGYSEEGASQQZYRARARPPRRREQGGRARARAQGGRLRAR

FIG. 8

.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	ZUQPNNEZL	255
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	SNNNNNNZL	272
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	ZZCSNHSZU	305
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	LKNNNNQTI	357
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	PLMZNKIIM	436
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	TEMZNMZFI	448
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	ULRYNRAZI	460
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	ZUCANNEZL	559
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	HEMZNHZFH	574
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	CDQINKIII	623
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	NNNNNNNRI	661
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	NNNNNNNRI	752
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	PLKZNELKI	825
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	NNNNNNNNU	858
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	PLPZNZZRL	882
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	NEMZNMZFI	1018
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	RKSSNNNUI	1114
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	PKSSNNNUI	1249
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	UEQNNNNUU	1340
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	ZUWANNEZL	1359
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	LEMZNMZFI	1397
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	ULRYNRLZI	1411
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	ZULANNEZL	1539
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	PRQRNUEYU	1552
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	PRKRNUEYU	1617
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	SSILNNKGM	1629
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	KSTNNTKKL	1695
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	RUUNNSNNI	1735
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	NNNNNNNHU	1778
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	IAGENKIII	1898
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	ZAUNNSNNI	2091
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	ZZRANRPUI	2104
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	IIRANRLRU	2156
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	QAFANNTLL	2334
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	ZKSRNEDPI	2370
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	NNNNNZTKU	2409
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	QIPANNNSI	2430
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	SMLNNKADU	2548
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	ZRPRNRKRL	2585
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	RKLNRRRII	2786
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	LSPNNTIKL	2863
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	SKIKNQRII	2901
.#selfWNSDTA_bin.bin	[A-Z]{4}N[A-Z]{3}[LMIU]	SNIKNHLSI	2981

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FIG. 9

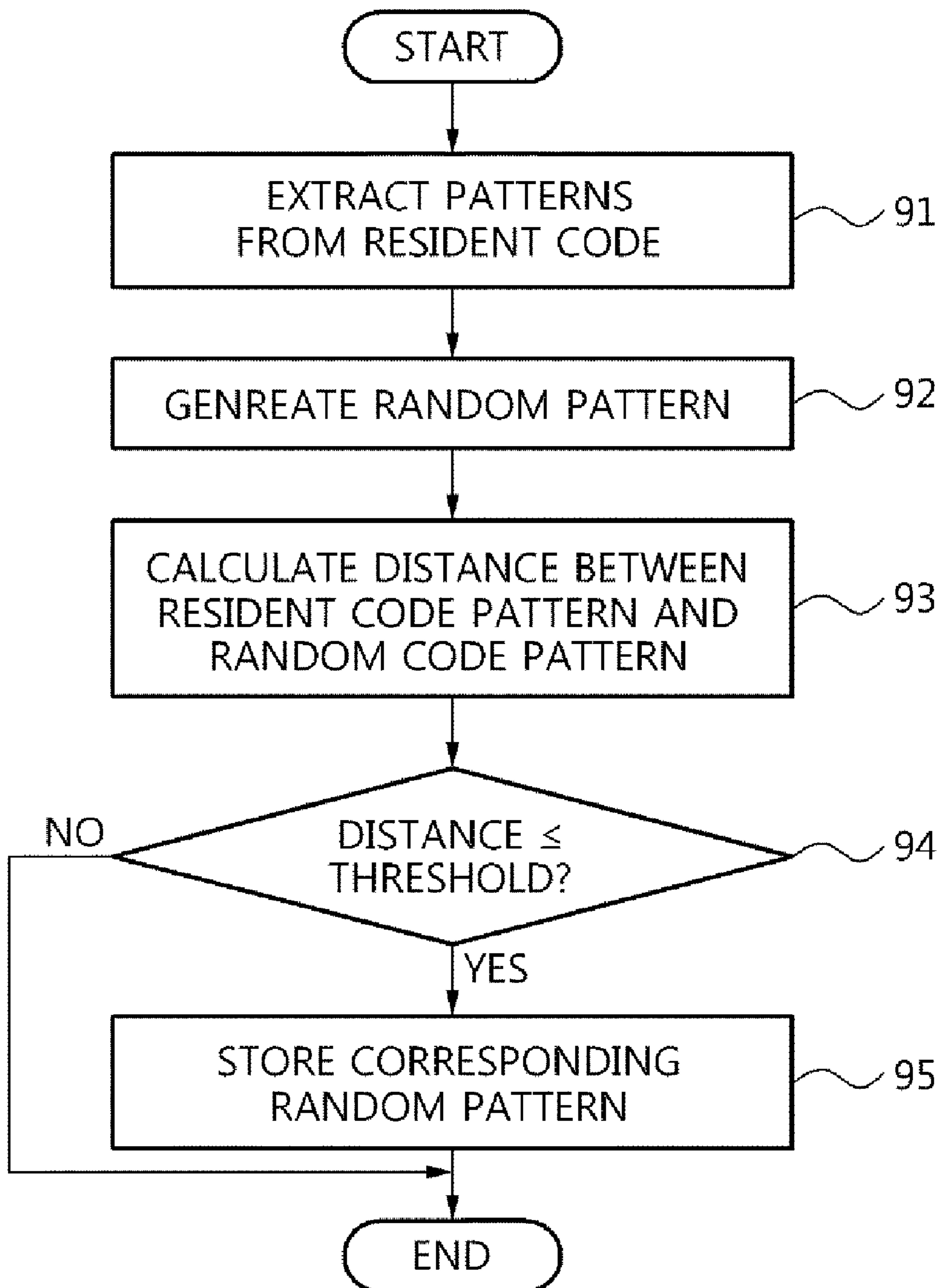
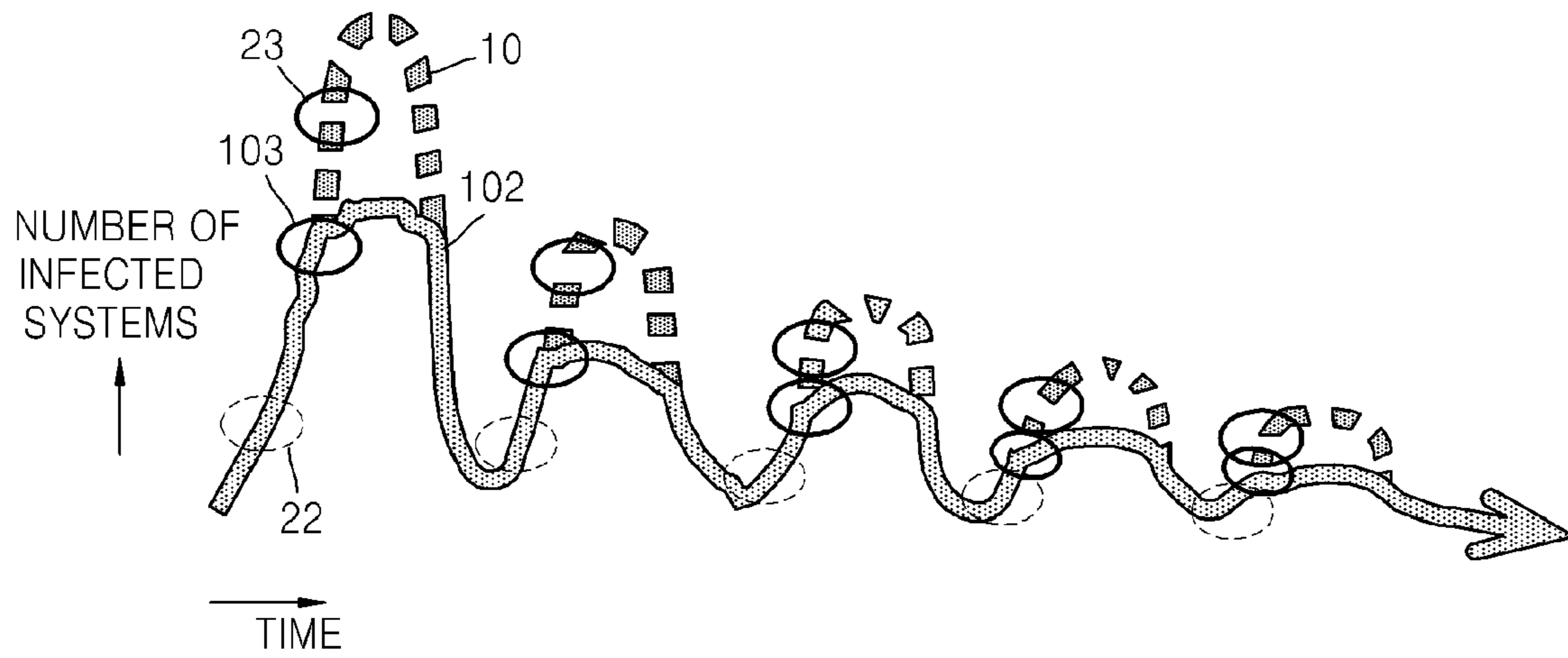


FIG. 10



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METHOD OF AND APPARATUS FOR MONITORING CODE TO DETECT INTRUSION CODE

This application claims the benefit of Korean Patent Application No. 10-2005-0135839, filed on Dec. 30, 2005, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein in its entirety by reference.

TECHNICAL FIELD

The present invention relates to a method of and apparatus for monitoring code to detect an intrusion code, and more particularly, to a method of and apparatus for monitoring application code executed in a computer to determine whether the application code is intrusion code or resident code.

BACKGROUND

Malicious code (malicious software, or malware) denotes all kinds of computer-executable code such as programs, macros, and scripts that are maliciously made to damage computer systems.

FIG. 1 shows the life cycle of a malicious code. Referring to FIG. 1, the life cycle of the malicious code includes a generation/opening period **10** in which the malicious code is generated and provided to the public, a distribution/spreading period **11** in which files infected with the malicious code are distributed and spread over a communication network, a recognition (active) period **12** in which the malicious code is active and a user recognizes the malicious code, a degeneration period **13** in which a vaccine program is updated and the malicious code is removed from a user's system, and an extinction period **14** in which the malicious code disappears.

FIG. 2A shows the life cycle of a malicious code variant. In FIG. 2A, the horizontal axis denotes time, and the vertical axis denotes the number of infected systems. Referring to FIG. 2A, after new malicious code **20** appears and disappears, a variant **21** of the malicious code appears continuously, thereby increasing the life cycle of the malicious code.

FIG. 2B shows time points when action is taken against malicious code. Reference numeral **22** denotes a time point when a user thinks that a vaccine program should be updated in order to cope with the malicious code, and reference numeral **23** denotes a time point when the vaccine program is actually updated. Referring to FIG. 2B, there is a time difference between time points **22** and **23**. The time difference is caused by time-consuming processes of analyzing the malicious code after the malicious code is already spread, drawing up a proper scheme and updating the vaccine program according to the scheme.

Further an appearance of malicious code variants causes an increase in time and effort to analyze the malicious code.

SUMMARY

The present invention provides a method of and apparatus for monitoring target code to determine whether the target code is an intrusion code or a resident code by extracting code pattern from the target code and comparing the extracted code pattern with code pattern reflecting the characteristics of the resident code.

According to an aspect of the present invention, a method of monitoring a target code to determine whether the target code is an intrusion code includes: extracting a first code pattern from the target code; loading a second code pattern

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from a storage unit; calculating the distance between the first code pattern and the second code pattern; and determining whether the target code is the intrusion code by comparing the calculated distance with a threshold.

According to another aspect of the present invention, an apparatus for monitoring a target code is used to determine whether the target code is an intrusion code intruding into a system. The apparatus includes a code pattern extracting unit and a code determining unit. The code pattern extracting unit extracts a first code pattern from the target code. The code determining unit determines whether the target code is the intrusion code by calculating a distance between the first code pattern and input second code pattern and comparing the calculated distance with a threshold.

According to a further aspect of the present invention, whether a target code is a resident code or an intrusion code is determined by using a mechanism of the self/non-self discrimination in a biological immune system, and thus the intrusion code determining efficiency can be improved. Accordingly, a vaccine program can be updated more rapidly and thus the malicious code can be treated more quickly.

DESCRIPTION OF DRAWINGS

The above and other features and advantages of the present invention will become more apparent by describing in detail exemplary embodiments thereof with reference to the attached drawings in which:

- FIG. 1 shows the life cycle of a malicious code;
- FIG. 2A shows the life cycle of a malicious code variant;
- FIG. 2B shows points of time when action is taken against a malicious code;
- FIG. 3 is a block diagram of a code monitoring apparatus according to an embodiment of the present invention;
- FIG. 4 is a flowchart of a code pattern extracting process in the code pattern extracting unit depicted in FIG. 3;
- FIG. 5 shows an exemplified hexadecimal code loaded as a monitoring target code;
- FIG. 6 shows an exemplified DNA code encoded from a hexadecimal code;
- FIG. 7 shows a protein code replaced from the DNA code of FIG. 6 according to a codon rule;
- FIG. 8 shows examples of code extracted from the protein code of FIG. 7 according to predetermined conditions;
- FIG. 9 is a flowchart showing a process of storing a reference code pattern in a storage unit depicted in FIG. 3; and
- FIG. 10 shows life cycles of a malicious code variant when code pattern extracting methods of the conventional art and an embodiment of the present invention are used.

DETAILED DESCRIPTION

The present invention will now be described more fully with reference to the accompanying drawings.

There is a DNA-based molecular computing technology employing DNA molecules in a field of molecular information processing technology that process information using bio-molecules. Basically the DNA-based molecular computing stores information to a DNA sequence and processes the information using chemical characteristics of a DNA molecule. Since cells forming the immune system can cope with a new antigen as well as memorize previously experienced antigens, various fields such as pattern recognition and feature extraction adopts the DNA-based molecular computing technology in order to use the characteristics of the immune system cells. The present invention uses the concept of DNA-

based molecular computing technology to monitor code and determine whether the code is an intrusion code.

The core of the present invention is self/non-self classification inspired by the processes of biological immune system, where self and non-self are defined as normal and malicious codes, respectively. Similarly to that of the biological counterpart, the present embodiment realizes the self-learning mechanism that is capable of adapting itself to the unknown intrusion code. This means it can determine a specific code belongs to either self or non-self leading to a declaration of the latter as being potentially harmful.

FIG. 3 is a block diagram of a code monitoring apparatus according to an embodiment of the present invention. The code monitoring apparatus includes a code pattern extracting unit 31 and a code determining unit 32. The code monitoring apparatus may further include a storage unit 33 storing immunity reference patterns for determining whether a target code is an intrusion code or a resident code. The code monitoring apparatus may further include a malicious code predicting unit 34. The malicious code predicting unit 34 predicts whether the intrusion code is a malicious code, when the code determining unit 32 determines that the target code is the intrusion code. The storage unit 33 can be a general data storage device such as a memory, an MD, a CD, and a DVD.

The code pattern extracting unit 31, first, extracts a code with a predetermined length to be used for the determination from the target code at a predetermined location. The code may be extracted from predetermined portions of the entire target code in a predetermined rate. For example, when the target code contains 1000 bytes, the code of 100 bytes may be extracted from the target code. In this case, the 100 byte code may be a set of 10 codes, each of which is of 10 bytes and extracted at different positions.

Further, the extracted code has uniqueness distinguished from other code extracted from other target codes. If the extracted code is not distinguished from the other codes, another code is extracted from the target code in the above-described way.

For a code pattern extraction, the present embodiment imitates an antigen presenting system, which monitors a portion of the antigen for an immune test in the biological immune system. That is, the antigen presenting system is applied to the target code for a code conversion and then code patterns are extracted on the converted code. In this embodiment, the code patterns are extracted from the target code by extracting protein codes from a DNA sequence and applying a self/non-self discrimination mechanism in the antigen presenting system to the extracted protein codes.

FIG. 4 is a flowchart of a code pattern extracting process of the code pattern extracting unit 31 employing the concept of the biological immune system.

In operation 41, a path of an execution code is tracked and the entire execution code is loaded. The execution code may be loaded in one of the following time points when: a file is copied to a computer system, a file is transmitted through an email etc., over a network, a user runs an execution file, and a user sets with respect to an anti-malicious code program. FIG. 5 shows an exemplified hexadecimal code 52 of the loaded code. Reference numeral 51 denotes the location of the hexadecimal code 52.

In operation 42, the loaded code is encoded into DNA code. The encoding is performed by dividing the value of each byte of the hexadecimal code shown in FIG. 5 by 4, and replacing the remainder 0, 1, 2, or 3 thereof with DNA bases, A, T, G, or C, respectively. An example of the encoding result is shown in FIG. 6.

In operation 43, the DNA code is converted into a protein code. The conversion is performed according to a well-known human codon rule. The human codon rule is shown in Table 1 below.

TABLE 1

Amino acid	Substitution value	Codon
Alanine	A	GCA, GCC, GCG, GCT
Cysteine	C	TGC, TGT
Aspartic acid	D	GAC, GAT
Glutamic acid	E	GAA, GAG
Phenylalanine	F	TTC, TTT
Glycine	G	GGA, GGC, GGG, GGT
Histidine	H	CAC, CAT
Isoleucine	I	ATA, ATC, ATT
Lysine	K	AAA, AAG
Leucine	L	TTA, TTG, CTA, CTC, CTG, CTT
Methionine	M	ATG
Asparagine	N	AAC, AAT
Proline	P	CCA, CCC, CCG, CCT
Glutamine	Q	CAA, CAG
Arginine	R	CGA, CGC, CGG, CGT
Serine	S	TCA, TCC, TCG, TCT, AGC, AGT
Threonine	T	ACA, ACC, ACG, ACT
Valine	V	GTA, GTC, GTG, GTT
Tryptophan	W	TGG
Tyrosine	Y	TAT
Stop Codons	Z	TAA, TAG, TGA

Referring to Table 1, for example, codon GCA of the DNA code is replaced with "A." FIG. 7 shows the substitution result for the DNA code of FIG. 6 obtained using Table 1.

In operation 44, the code pattern is extracted from the protein code shown in FIG. 7. The code pattern is obtained by extracting a portion corresponding to a binding pattern of a Major Histocompatibility Complex 1 (MHC1) molecule, a mechanism used for self/non-self discrimination in the biological immune system, from the protein code.

The MHC1 molecule binding pattern can be expressed by the following two formulas.

$$[A-Z]\{2\}Y[A-Z][YF][A-Z]\{2\}[LMIV] \quad (a)$$

$$[A-Z]\{4\}N[A-Z]\{3\}[LMIV] \quad (b)$$

where [A-Z] denotes a selectable range from A to Z, and {2} denotes the number of successive letters.

FIG. 8 shows examples extracted from the protein code of FIG. 7 according to one of the two equations. Referring to FIG. 8, reference numerals 81, 82, 83, and 84 denote file names, patterns satisfying equation (a) or (b), protein codes obtained using equation (a) or (b), and locations of the protein codes 83 in a file, respectively.

The code determining unit 32 shown in FIG. 3 loads a reference code pattern stored in the storage unit 33 and compares the loaded reference code pattern with the code pattern extracted by the code pattern extracting unit 31 to determine whether the extracted code is a resident code or an intrusion code.

Here, the reference code pattern is previously determined to be the reference code pattern of immunity using a resident code by the code pattern extracting unit 31 and by the code determining unit 32, and then stored in the storage unit 33.

FIG. 9 is a flowchart of a process of storing immunity reference patterns in the storage unit 33. In operation 91, a code pattern is extracted from a resident code. The extraction of the patterns is performed according to the process shown in FIG. 4.

In operation 92, a random pattern is created. The random pattern is randomly generated to have the same length as the

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pattern extracted from the resident code. In operation **93**, the distance between the resident code pattern and i-th random pattern is calculated. The distance may be calculated using various methods. For example, as shown in Equation 1 below, the distance may be calculated by squaring differences in alphabetic order and adding all the squared values.

$$dist_i(S, T) = \sum_{j=1}^N \sum_{k=1}^n (s_{jk} - t_{ik})^2 \quad \text{Equation 1}$$

where S, T, N, and n denote the resident code patterns, the random patterns, the number of the resident code patterns, and the pattern length, respectively.

In operation **94**, the distance calculated using Equation 1 with respect to the i-th random pattern is compared with a second threshold. If the distance is equal to or less than the

second threshold, the i-th random pattern is stored in the storing unit **33** as a reference code pattern in operation **95**.

The second threshold is a predetermined value and its minimum value is selected to be a half of the distance between two code patterns selected arbitrarily from the resident code pattern distribution. The higher the threshold is set, the more the reference code patterns, while the lower the threshold is set, the fewer the reference code patterns.

The code determining unit **32** calculates the distance between the reference code pattern stored in the storage unit **33** and the pattern extracted from the target code by the code pattern extracting unit **31** according to the process shown in FIG. **9** as in the following Equation.

$$dist(S, T) = \sum_{i=1}^N \sum_{j=1}^M \sum_{k=1}^n (s_{jk} - t_{ik})^2 \quad \text{Equation 2}$$

where S, T, N, M, and n denote the reference code patterns, the patterns extracted from the target code, the number of the reference code patterns, the number of the patterns extracted from the target code, and a length of the patterns of the reference code and target code, respectively.

If the distance calculated using Equation 2 is less than or equal to a first threshold, it is determined that the target code is a resident code. If the distance is greater than the first threshold, it is determined that the target code is an intrusion code.

If the code determining unit **32** determines that the target code is the intrusion code, the malicious code predicting unit **34** determines whether the intrusion code is a malicious code. The determination by the malicious code predicting unit **34** is

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performed based on user's experiences and the suspected malicious code. General symptoms of the malicious code can be detected from file characteristics, goat file tests, changes in processes, threads, and registries, network ports, code emulation, execution code debugging or system monitoring, etc. The symptoms of the malicious code may vary according to the type of the malicious code, such as spyware, a worm, a bot, a trojan, a file virus, and a macro virus, and whether the malicious code is compressed.

The determination of the malicious code may be patternized or automated based on a user's experiences. When the intrusion code is determined as a malicious code, the malicious code predicting unit **34** may stop the execution of the corresponding code or other codes and generate an alarm to other computers over a network.

Table 2 illustrates experimental results that the target code is determined to be the intrusion code according to the first thresholds and the reference code pattern generation rates.

TABLE 2

	Threshold								
	3500	3300	3100	2900	2700	2500	2300	2100	1900
Rate					1.E-06				
#1	0%	25%	37.5%	37.5%	50%	50%	50%	62.5%	37.5%
#2	12.5%	12.5%	37.5%	37.5%	50%	50%	50%	50%	50%
Rate					5.E-06				
#1	12.5%	37.5%	50%	50%	62.5%	62.5%	62.5%	62.5%	50%
#2	12.5%	12.5%	50%	62.5%	50%	62.5%	62.5%	62.5%	50%
Rate					1.E-05				
#1	12.5%	37.5%	50%	62.5%	62.5%	87.5%	62.5%	50%	62.5%
#2	12.5%	25%	50%	62.5%	62.5%	62.5%	62.5%	75%	62.5%

Referring to Table 2, the rate denotes the reference code pattern generation rate, namely, a rate of the number of actually generated reference code patterns with respect to the number of all of the possibly generated reference code patterns. For example, if the length of the pattern is n, and the number of letters used for the pattern is m, the number of all of the possibly generated pattern will be m^n . The generation rate means that, for example, $1/10$, $1/100$. . . of m^n the possible patterns are actually generated as the reference code patterns. In Table 2, the intrusion code determination performance is measured using the numbers of reference code patterns corresponding to the reference code generation rate of 1/1,000,000, 5/1,000,000, and 1/100,000, respectively.

According to Table 2, when the first thresholds are 2700, 2500, and 2300, the intrusion code determination performance is high. Further, as the reference code generation rate increases, the intrusion code determination efficiency becomes high.

To evaluate the intrusion code determination performance of the present invention, another experiment was performed on malicious code samples evading conventional vaccine programs.

Among 48,471 malicious code samples, 17,885 malicious code samples were detected by a conventional vaccine program, and 30,506 malicious code samples evaded the conventional vaccine program. For malicious codes determined to be the intrusion code according to the self/non-self discrimination on 2,575 malicious code samples randomly selected from the 30,506 evasive malicious code samples, the present invention shows 48% and 68% determination rates when the first threshold is set to 2700 and the reference code pattern generation rate is set to 1.E-06 and 1.E-05, respectively. Conse-

quently, the present invention detects evasive malicious code samples as intrusion codes that are potentially harmful to the systems.

FIG. 10 shows the life cycles of a malicious code variant according to the conventional art and the present invention. Reference numeral 10 denotes the life cycle of the malicious code variant according to the conventional art, and reference numeral 102 denotes the life cycle of the malicious code variant according to the present invention. Reference numeral 22 denotes a time point when a user thinks that a vaccine program should be updated for curing the malicious code, and reference numeral 23 denotes a time point when the vaccine program is actually updated according to the conventional art. Reference numeral 103 denotes a time point when the vaccine program is actually updated according to the present invention. Referring to FIG. 10, the malicious code can be reported to a vaccine program distributor more rapidly in the present invention than in the conventional art by determining whether a target code is an intrusion code and predicting whether the intrusion code is a malicious code. Therefore, the vaccine program can be updated more quickly.

In addition to the above-described exemplary embodiments, exemplary embodiments of the present invention can also be implemented by executing computer readable code/instructions in/on a medium, e.g., a computer readable medium. The medium can correspond to any medium/media permitting the storing and/or transmission of the computer readable code.

The computer readable code/instructions can be recorded/transferred in/on a medium in a variety of ways, with examples of the medium including magnetic storage media (e.g., ROM, floppy disks, hard disks, etc.), optical recording media (e.g., CD-ROMs, or DVDs), random access memory media, and storage/transmission media such as carrier waves. Examples of storage/transmission media may include wired or wireless transmission (such as transmission through the Internet). The medium may also be a distributed network, so that the computer readable code/instructions is stored/transferred and executed in a distributed fashion. The computer readable code/instructions may be executed by one or more processors.

While the present invention has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present invention as defined by the following claims.

The invention claimed is:

1. A method of monitoring a target code to determine whether the target code is an intrusion code to a system or a resident code in the system, the method comprising:
 extracting a first code pattern from the target code;
 loading a second code pattern from a storage unit;
 calculating a distance between the first code pattern and the second code pattern; and
 determining whether the target code is the intrusion code by comparing the calculated distance with a first threshold, wherein the extracting of the first code pattern comprises:
 encoding the target code into a DNA base sequence;
 replacing the DNA base sequence with a corresponding protein value; and
 extracting the first code pattern satisfying a predetermined condition from the generated sequence according to the replacement.

2. The method of claim 1, wherein the first code pattern is extracted from a pre-determined portion of the target code, with respect to each target code, and the extracted first code pattern is unique.

3. The method of claim 1, wherein an antigen-presenting system for biological immunity determination is applied to the target code for code conversion and a portion having the predetermined pattern is extracted from the converted code.

4. The method of claim 1, wherein the encoding of the target code comprises:
 performing modulo operations on the target code in a byte unit by a number of DNA bases; and
 replacing each remainder obtained through the modulo operation with one of the DNA bases.

5. The method of claim 1, wherein the replacing of the DNA base sequence comprises replacing three consecutive bases of the DNA sequence with a value corresponding to the protein according to a codon rule.

6. The method of claim 1, wherein the first code pattern extracted from the replaced value satisfies one of binding pattern conditions of a MHC 1 (Major histocompatibility complex 1) molecule.

7. The method of claim 1, wherein the loading of the second code pattern comprises:
 extracting a third code pattern from a resident code;
 producing a random pattern having a same length as the third code pattern;
 calculating a second distance between the produced random pattern and the third code pattern; and
 storing the random pattern whose second distance is less than a second threshold in the storage unit as the second code pattern.

8. The method of claim 7, wherein the third code pattern is extracted in a predetermined length from the resident code at a predetermined location.

9. The method of claim 7, wherein an antigen presenting system for biological immunity determination is applied to the resident code for code conversion and a portion having a predetermined pattern is extracted as the third code pattern from the converted code.

10. The method of claim 7, wherein the extracting of the third code pattern comprises:
 encoding the resident code into a DNA base sequence;
 replacing the DNA base sequence with a corresponding protein value; and
 extracting the third code pattern satisfying a predetermined condition from the replaced value.

11. The method of claim 10, wherein the encoding of the resident code comprises:
 performing modulo operations on the resident code in a byte unit by a number of DNA bases; and
 replacing each remainder obtained through the modulo operation with one of the DNA bases.

12. The method of claim 10, wherein the replacing of the DNA sequence comprises replacing three consecutive bases of the DNA sequence with a value corresponding to the protein according to a codon rule.

13. The method of claim 10, wherein the third code pattern extracted from the replaced value satisfies one of binding pattern conditions of a MHC1 molecule.

14. The method of claim 7, wherein the second threshold has a minimum value of a half of a distance between two code patterns selected from a code pattern distribution of the resident code.

15. The method of claim 7, wherein each of the second distance is calculated as a sum of squares of differences of an alphabetical order between each random pattern and the third code pattern.

16. The method of claim 1, wherein the distance is calculated as a sum of squares of differences of an alphabetical order between the first code pattern and the second code pattern.

17. The method of claim 1, further comprising:
determining the target code is a malicious code if the target code is determined to be the intrusion code.

18. An apparatus for monitoring a target code to determine whether the target code is an intrusion code to a system or a resident code in the system, the apparatus comprising:

a code pattern extracting unit arranged to extract a first code pattern from the target code; and

a code determining unit arranged to determine whether the target code is the intrusion code by calculating a distance between the first code pattern and an input second code pattern and comparing the calculated distance with a first threshold,

wherein the code pattern extracting unit applies an antigen-presenting system for biological immunity determination to the target code for code conversion and extracts a portion having a predetermined pattern as the first code pattern from the converted code, and

wherein the code pattern extracting unit extracts the first code pattern by encoding the target code into a DNA base sequence, replacing the DNA base sequence with a corresponding protein to form a protein array and extracting the first code pattern satisfying a predetermined condition from the generated sequence according to the replacement.

19. The apparatus of claim 18, wherein the code pattern extracting unit extracts the first code pattern being unique to the target code from a predetermined portion of the target code.

20. The apparatus of claim 18, wherein the predetermined condition is any one of a binding pattern conditions of a MHC1 molecule.

21. The apparatus of claim 18, further comprising a storage unit storing the second code pattern,
wherein

the code pattern extracting unit extracts a third code pattern from the resident code and generates a random pattern having a same length as the third code pattern, and

the code determining unit calculates each second distance between the produced random pattern and the extracted third code pattern and stores a corresponding random pattern in the storage unit as the second code pattern if each of the second distances is less than a second threshold.

22. The apparatus of claim 18, further comprising a malicious code predicting unit arranged to determine whether the target code is malicious if the code determining unit determines that the target code is the intrusion code.

23. A method of extracting a code pattern to monitor a target code to determine whether the target code is an intrusion code to a system or a resident code in the system, the method comprising:

extracting a code pattern from the resident code;
producing a random pattern corresponding to the extracted code pattern;

calculating a distance between the random pattern and the code pattern; and

extracting a corresponding random pattern as a code pattern for biological immunity determination if the calculated distance is less than a threshold value, wherein the extracting of the code pattern comprises:

encoding the resident code into a DNA base sequence;
replacing the encoded DNA base sequence with a corresponding protein value; and

extracting a pattern satisfying a predetermined condition as the code pattern.

24. The method of claim 23, wherein the extracting of the code pattern applies an antigen-presenting system for biological immunity determination to the resident code for code conversion and extracts a portion having a predetermined pattern from the converted code.

25. The method of claim 23, wherein the encoding of the resident code into the DNA base sequence comprises:

performing modulo operations on a number of DNA bases in a byte unit; and

replacing each remainder obtained through the modulo operation with one of the DNA bases.

26. The method of claim 23, wherein the replacing of the encoded DNA base sequence with the corresponding protein value replaces three consecutive DNA bases of the DNA base sequence with a value corresponding to the protein according to a codon rule.

27. The method of claim 23, wherein the extracting of the pattern satisfying the predetermined condition as the code pattern extracts a pattern satisfying any one of a binding pattern conditions of a MHC1 molecule.

28. An apparatus that extracts a code pattern to monitor a target code to determine whether the target code is an instruction code to a system or a resident code in the system, the apparatus comprising:

a code pattern extracting unit extracting a code pattern from the resident code;

a random pattern producing unit producing a random pattern corresponding to the extracted code pattern having a same length as the extracted code pattern;

a distance calculating unit calculating a distance between the produced random pattern and the extracted code pattern; and

a code pattern storage unit storing a corresponding random pattern as a code pattern for biological immunity determination if the calculated distance is less than a threshold value, wherein the code pattern extracting unit comprises:

encoding the resident code into a DNA base sequence;
replacing the encoded DNA base sequence with a corresponding protein value; and

extracting a pattern satisfying a predetermined condition as the code pattern.